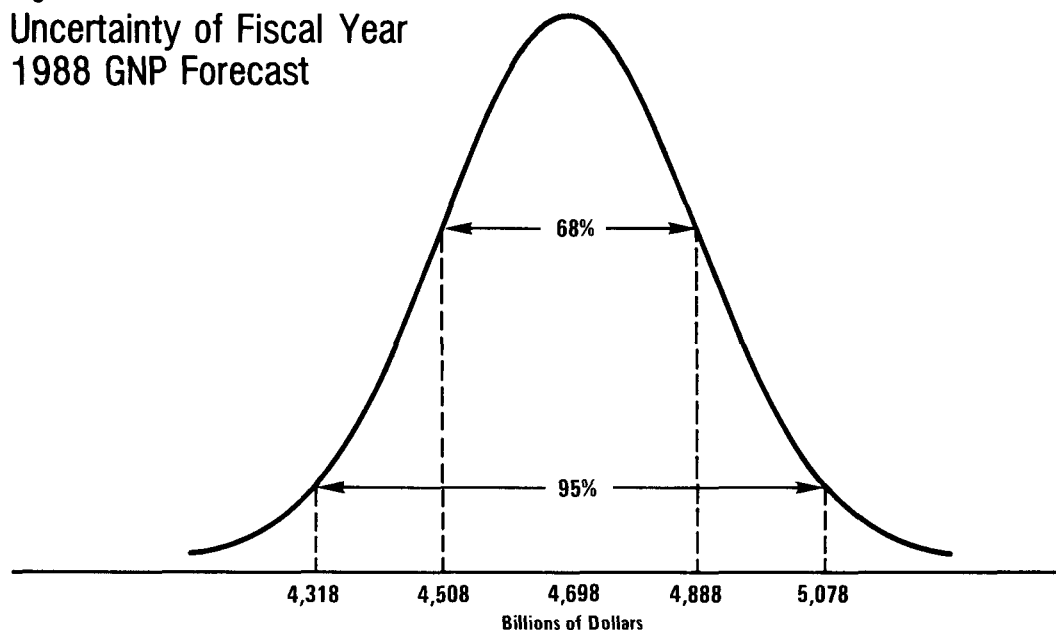


assumptions over these years was \$26 billion. (The root mean-square-error is similar to the standard deviation but reflects the fact that the average economic error during the 1980s was not zero.) While this estimate suggests a smaller range of uncertainty than the model-based approach, it must be remembered that the economy was smaller in the 1980-1987 period than it will be in 1988. If the estimate is adjusted to reflect the intervening growth in GNP, the resulting root mean-square-error in revenues due to inaccurate economic assumptions would be about \$36 billion.

Uncertainty in budget projections can arise, of course, from uncertainty in forecasting other economic variables, notably interest rates. But errors in GNP forecasts and interest-rate forecasts are not likely to be independent. For example, underestimating inflation may lead to underestimates both of nominal GNP and of nominal interest rates. CBO is currently developing estimates of uncertainty that will take interest-rate uncertainties into account. In the meantime, the estimates involving GNP alone provide a good indication of the size of errors in budget projections that are likely to result from inaccurate economic forecasts.

Figure III-4.

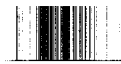
Uncertainty of Fiscal Year
1988 GNP Forecast



SOURCE: Congressional Budget Office.

APPENDIXES





APPENDIX A

SOURCES FOR ANALYZING

ECONOMIC AND BUDGET ERRORS

Chapter III compared the budget estimates contained in the Congressional budget resolutions with the actual outcomes, reviewed the forecasting records of CBO and several other forecasters, and also presented some mechanical forecasts. This appendix provides the data sources for these analyses.

BUDGET RESOLUTION ESTIMATES

The actual budget totals for fiscal years 1976 through 1985 shown in the Administration's 1988 budget are not comparable to the first budget resolutions for those years as a result of changes in the budgetary treatment of various items. Table A-1 shows actual totals that have been adjusted to agree with the accounting treatment used in the budget resolution.

Data for fiscal year 1985 and earlier years must be adjusted to exclude outlays (primarily the Federal Financing Bank, Strategic Petroleum Reserve, and Postal Service) that were considered off-budget before enactment of the Balanced Budget and Emergency Deficit Control Act of 1985. In addition, since fiscal year 1976, the budgetary treatment of seven items has changed: the Export-Import Bank, the Housing for the Elderly or Handicapped Fund, the earned income tax credit, the Exchange Stabilization Fund, gold sales, the Pension Benefit Guaranty Corporation, and Medicare premiums. ^{1/}

SOURCES OF INSTITUTIONAL FORECASTS

In undertaking any comparison of published economic forecasts, analysts must recognize fundamental distinctions between forecasts based on the availability of information, differing assumptions, and subjective judgments.

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1. See Congressional Budget Office, *An Analysis of Congressional Budget Estimates for Fiscal Years 1980-1982* (June 1984), pp. 59-62.

TABLE A-1. CONGRESSIONAL BUDGET RESOLUTIONS AND
ACTUAL BUDGET TOTALS (In billions of dollars)

Fiscal Year	Revenues	Outlays	Surplus or Deficit (-)
Fiscal Year 1976			
First resolution	298.2	367.0	-68.8
Second resolution	300.8	374.9	-74.1
Actual	299.2	364.8	-65.6
Fiscal Year 1977			
First resolution	362.5	413.3	-50.8
Second resolution	362.5	413.1	-50.6
Third resolution	347.7	417.5	-69.8
Third resolution amended	356.6	409.2	-52.6
Actual	356.9	401.9	-45.0
Fiscal Year 1978			
First resolution	396.3	461.0	-64.6
Second resolution	397.0	458.3	-61.3
Actual	401.1	449.9	-48.8
Fiscal Year 1979			
First resolution	447.9	498.8	-50.9
Second resolution	448.7	487.5	-38.8
Revised second resolution	461.0	494.5	-33.4
Actual	465.9	493.7	-27.7
Fiscal Year 1980			
First resolution	509.0	532.0	-23.0
Second resolution	517.8	547.6	-29.8
Revised second resolution	525.7	572.7	-47.0
Actual	520.1	579.6	-59.6
Fiscal Year 1981			
First resolution	613.8	613.6	0.2
Second resolution	605.0	632.4	-27.4
Revised second resolution	603.3	661.4	-58.0
Actual	602.6	660.5	-57.9
Fiscal Year 1982			
First resolution	657.8	695.4	-37.6
Revised second resolution	628.4	734.1	-105.7
Actual	617.8	728.4	-110.7

(Continued)

TABLE A-1. (Continued)

Fiscal Year	Revenues	Outlays	Surplus or Deficit (-)
Fiscal Year 1983			
First resolution	665.9	769.8	-103.9
Revised second resolution <u>a</u> /	604.3	807.4	-203.1
Actual	600.6	796.0	-195.4
Fiscal Year 1984			
First resolution <u>b</u> /	679.6	851.2	-171.6
Revised second resolution	672.9	845.6	-172.7
Actual	666.5	841.8	-175.3
Fiscal Year 1985			
First resolution <u>c</u> /	750.9	932.0	-181.2
Revised second resolution <u>c</u> /	736.5	935.9	-199.4
Revised second resolution <u>d</u> /	736.5	946.3	-209.8
Actual <u>c</u> /	734.1	936.8	-202.8
Actual <u>d</u> /	734.1	946.3	-212.3
Fiscal Year 1986			
First resolution	795.7	967.6	-171.9
Actual	769.1	989.8	-220.7
Fiscal Year 1987			
First resolution	852.4	995.0	-142.6
Current estimate	852.9	1,010.4	-157.4

SOURCE: Congressional Budget Office.

NOTE: Actual totals have been adjusted where necessary to agree with the budgetary treatment of various items for the budget resolutions and may, therefore, differ from the totals shown elsewhere in this report. Data for fiscal year 1984 and earlier years exclude outlays (primarily Federal Financing Bank, Strategic Petroleum Reserve, and Postal Service) that were considered off-budget before enactment of the Balanced Budget and Emergency Deficit Control Act of 1985.

- a. Outlays exclude amounts reserved pursuant to Section 2 of the budget resolution.
- b. Adjusted for enactment of reserve fund programs.
- c. On-budget only; see note.
- d. On- and off-budget combined; see note.



Determining which of these factors contributed to forecast errors, and to what extent, is often difficult, if not impossible. In the comparisons of forecasts in Chapter III, CBO attempted to make the alternative forecasts comparable by identifying the economic data used at the time the forecasts were made and, wherever possible, ensuring that these data were the same in each case. What remains are disparities resulting from differences in models, assumptions, and judgments.

Because published GNP forecasts are typically reported only on a calendar year basis, the fiscal year forecasts for CBO and OMB were calculated from unpublished quarterly data. The OMB fiscal year forecasts of GNP are consistent with the calendar year aggregates reported in the Administration's budget documents published in the winter of each year. Although CBO's forecasts of fiscal year GNP used in Chapter III are consistent with its published winter economic forecast, in several years the published forecasts were not used in budget resolutions or in subsequent CBO publications.

The first two columns of Table A-2 show the release dates for the National Income and Product Accounts (NIPA) data underlying the CBO and OMB forecasts in each year. In two of the ten years reported, CBO had an

TABLE A-2. DATA SOURCES FOR THE
INSTITUTIONAL FORECAST COMPARISON

Fiscal Year	NIPA Release Date		Publication Date		
	CBO	OMB	Chase	DRI	WEFA
1978	Nov. 1976	Dec. 1976	Nov. 1976	Dec. 1976	Dec. 1976
1979	Jan. 1978	Dec. 1977	Jan. 1978	Feb. 1978	Feb. 1978
1980	Dec. 1978	Dec. 1978	Dec. 1978	Jan. 1979	Dec. 1978
1981	Jan. 1980	Dec. 1979	Jan. 1980	Feb. 1980	Jan. 1980
1982	Jan. 1981	Jan. 1981	Jan. 1981	Feb. 1981	Jan. 1981
1983	Dec. 1981	Jan. 1982	Dec. 1981	Jan. 1982	Jan. 1982
1984	Jan. 1983	Jan. 1983	Jan. 1983	Feb. 1983	Feb. 1983
1985	Jan. 1984	Jan. 1984	Jan. 1984	Feb. 1984	Feb. 1984
1986	Jan. 1985	Jan. 1985	Jan. 1985	Feb. 1985	Feb. 1985
1987	Jan. 1986	Jan. 1986	Jan. 1986	Feb. 1986	Feb. 1986

SOURCE: Congressional Budget Office.

additional quarter of data (1979 and 1981), while in one year (1983) OMB had an additional quarter of data on which to base a forecast. The potential distortions stemming from these discrepancies in information could not be avoided since the two winter forecast series are available only once a year. The statistics on percentage errors tabulated in Chapter III (Table III-5), however, suggest that these distortions might not have been significant.

Because they are published monthly, the Chase Econometrics (Chase), Data Resources, Inc. (DRI), and Wharton Econometric Forecasting Associates (WEFA) forecasts could be chosen to avoid such discrepancies in information. They were selected to coincide with the NIPA data underlying the CBO forecasts. The publication dates for these forecasts are shown in the last three columns of Table A-2.

For the purpose of determining forecast accuracy, the series on actual budget year GNP was defined as the NIPA estimate of GNP released by the Commerce Department in the first November after the end of the fiscal year. For example, the actual GNP for budget year 1983 was taken to be the estimate of GNP in fiscal year 1983 as published in the *Survey of Current Business* in November 1983. The November estimates incorporate more complete underlying data than do the October estimates (the first published for each fiscal year). Later estimates were not used because, for fiscal year 1985, they would have involved conceptual revision in GNP. The actual GNP for fiscal year 1987 was estimated by averaging the latest available CBO, OMB, DRI, and WEFA forecasts.

Because the series on actual GNP have, in most cases, been revised many times since their original publication, this procedure for selecting them does not provide the best currently available estimate of historical GNP. The procedure does, however, have the virtue of providing an estimate of GNP that is close, in a conceptual sense at least, to the magnitude being forecast.

MECHANICAL FORECASTS

The mechanical forecasts discussed in Chapter III were the result of an automated forecasting procedure. Forty-two alternative procedures for specifying autoregressive equations for GNP were carried out. ^{2/} Once

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2. An autoregression of a time series is a regression of the current values of the series against its lagged values.



they were specified, the equations were then estimated for the data underlying the CBO forecast. Finally, a forecast for budget year GNP was made using each equation. The average of the 42 forecasts for each year is reported in Table III-5.

The equation specifications differed in the assumed data transformations (that is, levels and natural logarithms, no differencing, first differencing, second differencing, polynomial trend terms, and estimated pre-filters), and in the procedures for calculating the autoregressive lag lengths. For each of the NIPA data sets used by CBO (Table A-2), the alternative specifications for GNP were estimated over an historical period ending ten years prior to the release of the data and then forecast eight quarters ahead. Next, another quarter of data was added, the equations reestimated, and another two-year forecast generated. This process was repeated until the last available data point (that is, the dates in the CBO column of Table A-2) was reached. Statistics on out-of-sample forecast errors were collected on each round.

In each estimation period, the single most accurate (out-of-sample) specification over the previous decade was compared with the mean of all the alternative specifications. The mean forecast had a superior out-of-sample forecast record, and, therefore, it was used in Table III-5.

It should be stressed that the mechanical forecasts reported in Chapter III are not necessarily "optimal" as is usually understood in the literature on time-series analysis. ^{3/} Rather, they are merely intended to provide an indicator of the extent to which all economic forecasters might have been surprised by events unfolding in a given period. That the mechanical forecasters made large overestimates of budget year GNP in 1982 and 1983 just as did the human forecasters suggests that, to some extent, the economy during this period was experiencing "shocks" that surprised all forecasters. Since no models or forecasters are perfectly accurate, this string of shocks is itself not surprising, though, of course, it remains unpredictable.

3. For example, while it is not surprising that the average autoregressive forecast outperformed the single most accurate specification over time, the unweighted average of all the forecasts is not necessarily an optimal combination of these forecasts since it may not provide minimum mean-square-error predictions. This problem will be explored more fully in a future CBO staff working paper which will also provide details on the procedures and results summarized here.

ESTIMATING THE UNCERTAINTY OF CBO'S GNP FORECAST FOR FISCAL YEAR 1988

To estimate the degree of uncertainty in the CBO winter forecast of GNP for fiscal year 1988 (as published in January 1987), the procedure for model selection based on the November 1986 NIPA data was expanded to include several ARIMA model specifications. ^{4/} The ARIMA models were estimated and their forecasting performance simulated over the previous decade in a manner identical to that used for the autoregressive models described earlier. The ARIMA specification chosen had the lowest out-of-sample root-mean-square-errors (RMSEs) for eight-quarter-ahead forecasts of all models (mechanical and ARIMA) examined over the 1976-1986 period. ^{5/}

The ARIMA model selected was then simulated over the period that extends from the fourth quarter of 1986 to the third quarter of 1988. On each of 5,000 simulation rounds, a new series of equation residuals and a new set of equation coefficients were selected using a normal random number generator. On each round a forecast of GNP was made for fiscal year 1988. The results are summarized in Figure III-4 of Chapter III.

In constructing Figure III-4, the CBO forecast of January 1987 was superimposed on the distribution of simulated outcomes for fiscal year 1988, since it was only 0.3 standard deviations below the simulated mean. The distribution depicted in Figure III-4, moreover, was assumed to be normal for heuristic reasons, even though the design of the simulation experiment suggests some possible departures from normality. The experimental results did indicate, however, that skewness in the forecast distribution was small and, probably, statistically insignificant.

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4. Autoregressive, integrated, moving-average (ARIMA) models are developed in G.E.P. Box, and G.M. Jenkins, *Time Series Analysis: Forecasting and Control* (San Francisco: Holden-Day, Inc., 1970). Automatic procedures for ARIMA models are much harder to develop and implement on economic data and were therefore not included in the mechanical forecasting procedures described earlier. The ARIMA model chosen for the prospective analysis, however, produced budget year GNP forecasts comparable in accuracy with the mean mechanical forecasts reported in Chapter III.
 5. The ARIMA model was estimated on the first differences of the natural logarithm of GNP. The selected model included an autoregressive term at lag one and moving-average terms at lags of ten and eleven quarters. The moving-average terms are a bit odd for a seasonally adjusted series of this type. A "bootstrap" experiment was conducted to see if the improved forecast performance of the equation with these terms was robust. The experimental results suggested it was. The presence of these high-order moving average terms might be rationalized as manifestations of residual seasonality present in the components of nominal GNP.





APPENDIX B

ESTIMATES OF POTENTIAL OUTPUT

The Congressional Budget Office's medium-term projections of output are related to a projection of potential output--defined as the maximum level of output that is consistent with a constant rate of inflation. The projection of potential output depends in turn on an estimate of the nonaccelerating inflation rate of unemployment (NAIRU)--that is, the unemployment rate consistent with a stable inflation rate.

CBO has revised its estimate of NAIRU in the period from 1981 through 1992. The reestimate of NAIRU was motivated by the recent drop in the unemployment rate to a level close to the previously assumed level of NAIRU--a drop that did not seem to be accompanied by other signs of tightness in the economy (see Box I-2). A major argument for a lower estimate of NAIRU is the change in the demographic composition of the labor force.

Demographic changes matter because unemployment rates of groups within the labor force differ from one another. The aggregate unemployment rate can vary either as unemployment rates within such groups vary or as the relative proportions of such groups vary. CBO has calculated a series designed to isolate the effect that changes in the composition of the labor force would have on the aggregate unemployment rate if each group experienced its average unemployment rate. While changes in this series reflect demographic changes, its level has no particular meaning.

The civilian labor force was broken into 14 groups according to age and sex, and the average unemployment rate for each group over the 1948:I to 1987:I period was determined. ^{1/} The series was then calculated quarter-by-quarter by multiplying each group's average unemployment rate by its share of the labor force for that quarter, and summing the result over all groups. The series was then projected beyond the current period by using the Bureau of Labor Statistics' projections of labor force composition.

As Figure B-1 shows, this series, U^* , drops about 0.3 percentage point from 1980 to 1986 and an additional 0.2 percentage point from 1986 to 1992.

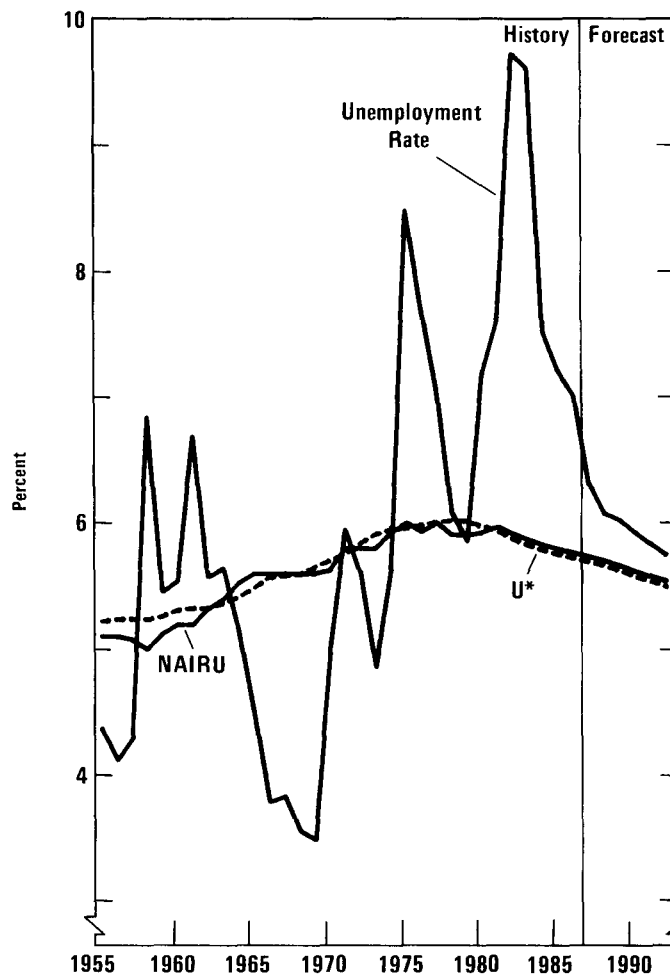
1. The age groups were: 16-19; 20-24; 25-34; 35-44; 45-54; 55-64; and 65 and older.





Figure B-1.
The Effect of
Demographics on the
Unemployment Rate

SOURCES: Congressional Budget Office; Department of Labor, Bureau of Labor Statistics; Robert J. Gordon, "Inflation, Flexible Exchange Rates, and the Natural Rate of Unemployment," in Martin N. Baily, ed., *Workers, Jobs, and Inflation* (Washington, D.C.: The Brookings Institution, 1982) pp. 89-158.

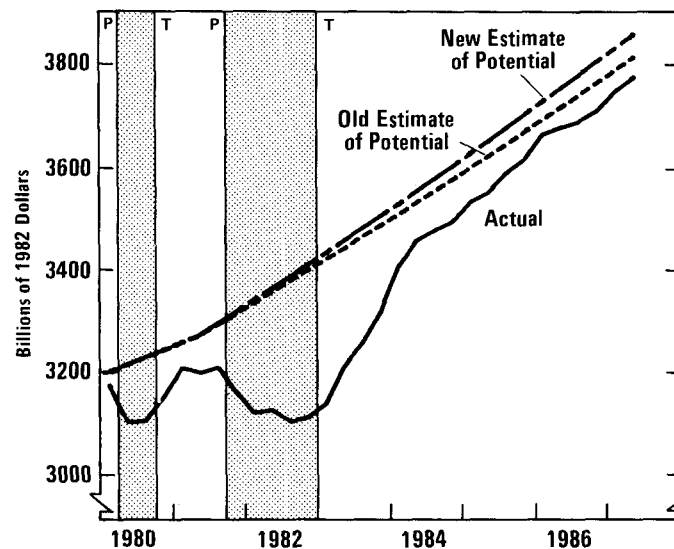


NOTE: Changes in U* are an estimate of the effect of demographic changes on the unemployment rate. The construction of U* is explained in the text.

Most of these reductions are accounted for by declines in the shares of young workers in the labor force, especially teenagers.

Changes in U* were taken to indicate changes in NAIRU resulting from changing labor-force demographics. For instance, if U* dropped by 0.1 percentage point over a given period, NAIRU would also be assumed to drop by 0.1 percentage point over that period. Thus, rather than remaining at 6 percent after 1980 (as was previously assumed), NAIRU drops to about 5.7 percent by 1986 and 5.5 percent by 1992.

Figure B-2.
Real Gross Domestic
Product



SOURCES: Congressional Budget Office; Department of Commerce, Bureau of Economic Analysis.

Once the estimate of NAIRU is established, potential real gross domestic product (GDP) can be estimated using the method described in CBO's January report. This method relates real GDP to the unemployment rate, NAIRU, and time trends representing peak-to-peak periods of the business cycle. The results, shown in Figure B-2, indicate that the new estimate is slightly higher than the January estimate. ^{2/} The gap between actual and potential real GDP in 1987:I is 2.2 percent of potential on the basis of the current series, whereas it would have been 2.0 percent on the basis of the old series and data available in January. On average, the historical gap based on the new potential series is 0.5 percent.

The estimates indicate that since the most recent business-cycle peak in 1981:III, the trend rate of growth of potential GDP has been 2.73 percent per year, while that of the potential labor force has been 1.58 percent per year. Thus, the most recent evidence indicates potential GDP is growing more rapidly than the potential labor force by 1.15 percentage points.

The projected growth of potential GDP, is assumed to continue to outpace that of the potential labor force by 1.15 percentage points. In turn,

2. The increase in the estimate of potential is the result of both the change in the estimate of NAIRU and the Commerce Department's upward revision in July of historical GNP data.



the potential labor force is assumed to grow at 1.3 percent per year through 1992--equal to the 1986 through 1992 annual average labor force growth rate projected on the most recent BLS moderate growth path. Together, these assumptions imply that potential GDP will grow at approximately 2.45 percent per year through 1992. The projected potential GNP is constructed from potential GDP by adding projected net factor service flows.

APPENDIX C

HISTORICAL ESTIMATES OF THE

STANDARDIZED-EMPLOYMENT DEFICIT





TABLE C-1. HISTORICAL ESTIMATES OF POTENTIAL GNP, NAIRU, AND THE STANDARDIZED-EMPLOYMENT DEFICIT

Years	Potential GNP (In Billions of Dollars)	NAIRU <u>a</u> /	Standardized- Employment Deficit (-)	
			In Billions of Dollars	As Percent of Potential GNP
1956	408	5.1	2	0.6
1957	435	5.1	3	0.6
1958	459	5.0	2	0.4
1959	484	5.1	-9	-1.9
1960	511	5.2	3	0.6
1961	535	5.2	4	0.7
1962	565	5.3	-3	-0.5
1963	597	5.4	-1	-0.1
1964	628	5.4	-5	-0.8
1965	665	5.6	-3	-0.4
1966	709	5.6	-11	-1.6
1967	760	5.6	-17	-2.3
1968	816	5.6	-35	-4.3
1969	892	5.6	-8	-0.9
1970	977	5.6	-7	-0.7
1971	1,061	5.7	-20	-1.9
1972	1,155	5.8	-20	-1.7
1973	1,253	5.8	-22	-1.7
1974	1,399	5.8	-11	-0.8
1975	1,585	6.0	-33	-2.1
1976	1,771	5.9	-46	-2.6
1977	1,976	6.0	-34	-1.7
1978	2,179	5.9	-53	-2.4
1979	2,448	5.9	-40	-1.6
1980	2,734	5.9	-51	-1.9
1981	3,057	6.0	-48	-1.6
1982	3,364	5.9	-51	-1.5
1983	3,595	5.9	-106	-3.0
1984	3,831	5.8	-130	-3.4
1985	4,054	5.8	-171	-4.2
1986	4,278	5.8	-185	-4.3

SOURCES: Congressional Budget Office; Robert J. Gordon, *Macroeconomics* (New York: Little, Brown, 1984), Appendix B, Table B-2, Column 6.

- a. The NAIRU (nonaccelerating inflation rate of unemployment) was referred to in some previous CBO publications as the stable inflation rate of unemployment.



